

**Citation:**

McCurdy SM, Mayes E, Hillers V, Kang DH, Edelfsen M. Availability, accuracy and response time of instant-read food thermometers for consumer use. *Food Prot. Trends*. 2004; 24(12): 961-968.

**Study Design:**

Randomized block trial, and cross-sectional survey component.

**Class:**

A - [Click here](#) for explanation of classification scheme.

**Research Design and Implementation Rating:**

NEUTRAL: See Research Design and Implementation Criteria Checklist below.

**Research Purpose:**

- To determine the accuracy and response time of a sampling of instant-read food thermometers
- To determine the availability of instant-read food thermometers to consumers in rural and urban areas of Idaho and Washington states.

**Inclusion Criteria:**

For Thermometer Accuracy and Response Time trial, thermometers had to be:

- Instant-read pocket food thermometers (dial or digital types)
- Available for purchase at local grocery, department and hardware stores, by catalog or Internet order, or free from Idaho Beef Commission during 2002 and 2003.

For Thermometer Availability surveys, surveys were conducted in:

- Department, grocery, kitchen specialty, hardware, drug and variety stores in four counties in Washington state (Grant, King, Spokane and Yakima) and six counties in Idaho (Ada, Bonneville, Boundary, Kootenai, Latah and Twin Falls)
- Internet retailers and mail order catalogs specializing in kitchen and cooking equipment.

**Exclusion Criteria:**

For Accuracy and Response Time of Thermometers trial:

- Food thermometers other than instant-read pocket food thermometers (dial or digital types)
- Food Thermometers not available for purchase at local grocery, department and hardware stores, by catalog or Internet order or free from Idaho Beef Commission during 2002 and 2003.

For Thermometer Availability surveys, surveys conducted in:

- Stores and locations other than department, grocery, kitchen specialty, hardware, drug and variety stores in four counties in Washington state (Grant, King, Spokane and Yakima) and six counties in Idaho (Ada, Bonneville, Boundary, Kootenai, Latah and Twin Falls)
- Internet retailers and mail order catalogs that do not specialize in kitchen and cooking equipment.

## **Description of Study Protocol:**

### **Recruitment**

- For Accuracy and Response Time of Thermometers trial, food thermometers chosen had to be:
  - Instant-read pocket food thermometers (dial or digital types)
  - Available for purchase at local grocery, department and hardware stores, by catalog and Internet order or free from Idaho Beef Commission during 2002 and 2003
- For Thermometer Availability Surveys: Department, grocery, kitchen specialty, hardware, drug and variety stores in four counties in Washington state (Grant, King, Spokane and Yakima) and six counties in Idaho (Ada, Bonneville, Boundary, Kootenai, Latah and Twin Falls) were visited to learn about the food thermometers for sale; 22 Internet retailers and mail order catalogs specializing in kitchen and cooking equipment were also investigated.

### **Design**

- For Accuracy and Response Time of Thermometers trial:
  - 21 models of instant-read pocket food thermometers (eight dial models and 13 digital models) were obtained (three units of each model were obtained if possible)
  - The accuracy (at 160°F) and the response time of the dial and digital instant-read thermometers were measured by use of a temperature-controlled water bath
  - Prior to testing each thermometer, the accuracy of the water bath temperature was verified by checking a glass, certified thermometer that was factory-calibrated to standards by the National Institute of Standards and Technology (NIST) and that was maintained in the water bath at a depth of four inches throughout testing
  - The stem of each thermometer (at room temperature, 75° to 81°F) was immersed in the 160°F water to a controlled depth (2.5 inches for dial thermometers and 1.5 inches for digital thermometers)
  - As the thermometer was lowered into the water bath, a stopwatch timer was started; timing was halted when the thermometer came within 0.5°F of its final temperature (determined in preliminary trials)
  - If off by 1°F or more, thermometers that could be calibrated were adjusted to 160°F before the response time test
  - Response time was tested three times for each thermometer
- For Thermometer Availability surveys:
  - Store surveyors were consumers who were instructed to record information for the types of thermometers offered for sale that were suitable for use in measuring the temperature of thin food items
  - Store surveyors were also instructed to survey a variety of stores most likely to be used by consumers looking for a food thermometer to purchase
  - The surveys represented a sampling of stores, rather than every store in the counties
  - Information collected included brand, model number, thermometer type, package instructions for use (if visually available on unopened package) and price

- Via Internet, survey of mail order catalogs were conducted by a consumer instructed to search for this information.

## Statistical Analysis

Not described in detail. These statistics were presented related to the Thermometer Accuracy and Response time trial:

- For temperature reading: Average of replicates
- For thermometer response time: Seconds with standard deviation
- For thermometer response time: Average of replicates.

## Data Collection Summary:

### Timing of Measurements

- For Trial on Thermometer Accuracy and Response Time:
  - Timing after thermometers were lowered into the water bath was halted when the thermometer came within 0.5°F of its final temperature
  - Response time was tested three times for each thermometer
- For Thermometer Availability surveys: Conducted in Washington and Idaho states in October 2001 through May 2002.

### Dependent Variables

- For Trial on Thermometer Accuracy and Response Time:
  - Variable 1: Accuracy of instant-read pocket thermometers
  - Variable 2: Response time to reach final temperature of instant-read pocket thermometers
  - Accuracy was measured (at 160° F) by use of a temperature-controlled water bath (12x18x5-inch deep, maintained at 160°F by a VWR Scientific Heater/Pump). Prior to testing each thermometer, the accuracy of the water bath temperature was verified by checking a glass, certified thermometer that was factory calibrated to standards by the National Institute of Standards and Technology (NIST) (Ertco, 122 ° to 176°F, partial immersion thermometer) and that was maintained in the water bath at a depth of four inches throughout testing.
  - Response time measured: The stem of each thermometer (at room temperature, 75° to 81°F) was immersed in the 160°F water to a controlled depth (2.5 inches for dial thermometers, and 1.5 inches for digital thermometers). As the thermometer was lowered into the water bath, a stopwatch timer was started; timing was halted when the thermometer came within 0.5 °F of its final temperature (determined in preliminary trials). If off by 1°F or more, thermometers that could be calibrated were adjusted to 160°F before the response time test
- For Thermometer Availability surveys: Brand, model, purchase source, NSF certified, cooking temperatures provided on case and ability to calibrate.

### Independent Variables

For trial on Accuracy and Response Time of Thermometers, 21 models of instant-read pocket food thermometers (three units of each model if possible) were used:

- Eight dial models

- 13 digital models.

## Description of Actual Data Sample:

- *Initial N:*
  - Thermometer accuracy and response time: Total of 57 thermometers were tested, including 21 models of instant-read pocket food thermometers (three units of each model if possible).
    - Eight dial models
    - 13 digital models
  - Thermometer Availability:
    - Total of 237 thermometers in 96 stores were surveyed on day of visit (173 in Washington State survey and 64 in Idaho State survey)
    - Total of 137 stores: Department (42), grocery (40), kitchen specialty (25), hardware (18) and drug or variety (13) stores, and 22 Internet retailers and mail order catalogs specializing in kitchen and cooking equipment
- *Location:* Idaho and Washington States.

## Summary of Results:

### Key Findings

For Thermometer Accuracy and Response Time trial:

- Both dial and digital instant-read thermometers were accurate within 2°F when tested in a 160°F calibrated water bath (all but one of the 57 thermometers were acceptably accurate when used for the first time after removal from packaging)
- Response time to reach 160°F from ambient temperature for dial thermometers (eight models) was 16 to 25 seconds (average 21 seconds)
- Response time to reach 160°F from ambient temperature for digital thermometers (13 models) was 10 to 31 seconds (average 18 seconds)
- Response time of replicate thermometers was reasonably consistent
- Thus, both types required an average of about 20 seconds to register the temperature at 160°F, although some took as little as 10 seconds and others as much as 30 seconds.

### Other Findings

Based on survey of availability of instant-read food thermometers to consumers in rural and urban areas of Idaho and Washington:

- The instant-read food thermometers were most available in:
  - Kitchen specialty stores (88% of stores surveyed)
  - Department stores (76%)
  - Grocery stores (73%)
  - Some were also available in some drug and variety stores and hardware stores
- 68% of grocery stores surveyed sold dial instant-read thermometers, but only 35% carried digital models
- Of the 99 models of thermometers identified in store surveys, 12 models had no instructions regarding use, cleaning or calibration.

## Author Conclusion:

- The accuracy of dial and digital instant read food thermometers available to consumers for measuring end-point temperature in small meat items is quite good (within 2°F for 56 of 57 individual thermometers tested)
- Response time to reach 160°F from room temperature varied from 10 to 31 seconds; long response times may discourage consumers from routine use of food thermometers to determine cooking end-point in thin or small meat items. Although three digital models had average response times of 13 seconds or less, shorter than any dial model average, two of the digital models also provided the longest response (26 and 31 seconds).
- The availability of food thermometers is good for urban consumers, but instant-read food thermometers may be more difficult to locate for rural consumers; a wide variety of choices are available over the Internet
- It is important that consumers receive accurate instruction about the insertion depth required, two to 2.5-inches or 0.5 inch, for dial and digital instant-read thermometers, respectively.

## Reviewer Comments:

*Funding source of study is unclear.*

## Research Design and Implementation Criteria Checklist: Primary Research

### Relevance Questions

1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

### Validity Questions

1.	Was the research question clearly stated?	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes

1.3.	Were the target population and setting specified?	Yes
<b>2.</b>	<b>Was the selection of study subjects/patients free from bias?</b>	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	N/A
2.4.	Were the subjects/patients a representative sample of the relevant population?	N/A
<b>3.</b>	<b>Were study groups comparable?</b>	???
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	???
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	N/A
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	???
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	???
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
<b>4.</b>	<b>Was method of handling withdrawals described?</b>	N/A
4.1.	Were follow-up methods described and the same for all groups?	N/A
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	N/A
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	N/A
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A



<b>5.</b>	<b>Was blinding used to prevent introduction of bias?</b>	<b>No</b>
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	<b>No</b>
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	<b>No</b>
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
<b>6.</b>	<b>Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were intervening factors described?</b>	<b>Yes</b>
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	<b>Yes</b>
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	N/A
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	N/A
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	N/A
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	N/A
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
<b>7.</b>	<b>Were outcomes clearly defined and the measurements valid and reliable?</b>	<b>???</b>
7.1.	Were primary and secondary endpoints described and relevant to the question?	<b>Yes</b>
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	<b>Yes</b>
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	<b>???</b>
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	<b>???</b>
7.5.	Was the measurement of effect at an appropriate level of precision?	<b>???</b>

7.6.	Were other factors accounted for (measured) that could affect outcomes?	???
7.7.	Were the measurements conducted consistently across groups?	Yes
<b>8.</b>	<b>Was the statistical analysis appropriate for the study design and type of outcome indicators?</b>	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	???
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	No
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	N/A
8.6.	Was clinical significance as well as statistical significance reported?	No
8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
<b>9.</b>	<b>Are conclusions supported by results with biases and limitations taken into consideration?</b>	No
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	No
<b>10.</b>	<b>Is bias due to study's funding or sponsorship unlikely?</b>	???
10.1.	Were sources of funding and investigators' affiliations described?	No
10.2.	Was the study free from apparent conflict of interest?	???